Working Draft

Implementation Plan

for the

Hawaii Geothermal Project

Environmental Impact Statement

Prepared by
The United States Department of Energy
Conservation and Renewable Energy

June 30, 1992

U.S. Department of Energy
Washington, D.C.

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In Cooperation with
County of Hawaii
County of Maui
National Marine Fisheries Service
National Park Service
State of Hawaii
United States Army Corps of Engineers
United States Fish and Wildlife Service
United States Geological Survey

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1. INTRODUCTION

The U.S. Department of Energy (DOE) is preparing an Environmental Impact Statement (EIS) that identifies and evaluates the environmental impacts associated with the proposed Hawaii Geothermal Project (HGP), as defined by the State of Hawaii in its 1990 proposal to Congress (ref). The EIS is being prepared pursuant to the requirements of the National Environmental Policy Act of 1969 (NEPA), as implemented by the President's Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508) and the DOE NEPA Implementing Regulations (10 CFR 1021), effective May 26, 1992, which now require Mitigation Action Plans. Mitigation Action Plans, completed in conjunction with the EIS and its Record of Decision (ROD), explain how measures designed to mitigate adverse impacts will be planned and implemented. This draft Implementation Plan (IP) identifies the issues raised in the scoping process and describes the approach to be used in preparing the EIS.

The State's proposal for the four-phase HGP consists of (1) exploration and testing of the geothermal resource beneath the slopes of the active Kilauea volcano on the Island of Hawaii (Big Island), (2) demonstration of deep-water power cable technology in the Alenuihaha Channel between the Big Island and Maui, (3) verification and characterization of the geothermal resource on the Big Island, and (4) construction and operation of commercial geothermal power production facilities on the Big Island, with overland and submarine transmission of electricity from the Big Island to Oahu and other islands. DOE prepared appropriate NEPA documentation for separate federal actions related to Phase 1 and 2 research projects, which have been completed. This EIS will consider Phases 3 and 4, as well as reasonable alternatives to the HGP. In this regard, in addition to considering non-geothermal alternative energy resources for power production

(including, but not necessarily limited to, coal, solar, biomass, and wind), the HGP EIS will consider the reasonable alternatives among submarine cable technologies; geothermal extraction, production, and power generating technologies; pollution control technologies; overland and submarine power transmission routes; sites reasonably suited to support project facilities in a safe and environmentally acceptable manner; and nonpower generating alternatives such as demand side management.

1.1 BACKGROUND

The HGP is the culmination of research and development efforts begun in the mid-1970s to explore the feasibility of using Hawaii's indigenous geothermal resource for the production of electricity. Geothermal exploration began in Hawaii in 1972 with funding from the National Science Foundation (NSF). A high-potential geothermal resource site was identified on the east rift of the Kilauea volcano on the Big Island. Subsequent exploratory drilling (also funded by NSF) between December 1975 and April 1976, resulted in a productive geothermal well at a depth of approximately 6000 feet. In 1976, the Energy Research and Development Administration (ERDA), a predecessor to DOE, funded the testing of the geothermal well, which was designated as the HGP-A well. In 1979, DOE, which succeeded ERDA, funded the development of a 3-MW demonstration power plant at the HGP-A site. In 1986, the HGP-A facilities were transferred by DOE to the State of Hawaii to be used for further research. The State has referred to this early exploration and testing of the Big Island geothermal resource as Phase 1 of the HGP.

DOE also provided funds for the Hawaii Deep Water Cable Program, referred to by the State of Hawaii as Phase 2 of the HGP, which was initiated in 1981. The goal of the program was to determine the technical and economic feasibility of constructing and operating a deep water submarine power transmission cable that would serve the island of Oahu and would operate for a 30-year period. This project, completed in 1991, demonstrated the feasibility of the deep water power transmission cable. Over an 11-year

period, DOE has provided approximately $33 million for geothermal and deep water cable research in Hawaii, which is about 80% of the HGP cost-shared effort.

The State of Hawaii considers the unknown extent of the geothermal resource as the primary obstacle to private investment and commercial development. State and private industry experts estimate that at least 25 commercial-scale exploratory wells will need to be drilled to verify the generating potential of the resource. To that end, Phase 3 activities would include well drilling, logging of cores from holes, measuring temperatures, collecting and analyzing geothermal fluid samples, and making downhole geophysical and geochemical measurements.

After resource characterization, the State of Hawaii's 1990 proposal forecasts that from 10 to 20 separate geothermal power plants of from 25-30 MW each could be developed. The actual number of plants would depend on the extent of the resource defined in Phase 3. Because the exact location of plants will not be known until Phase 3 is completed, the EIS will rely on best available data and information to predict development sites. Based on the physical characteristics of the resource and contemporary geothermal energy development practice, the State estimated that about 125 production wells and 30 injection wells may be needed to produce 500 MW. At the source, some power level greater than 500 MW will be required, considering power transmission losses. The plants most likely would be connected by a network of roads, piping, and overland power transmission lines. Overland and underwater transmission lines (300 kV AC or DC) would be constructed to distribute power to Oahu and other islands.

In 1990, the State projected that permitting and financing for Phase 3 and 4 would occur in 1991 and that 500 MW of power could be on-line by 2005. Compliance with State and federal legal and environmental requirements is likely to extend this schedule.

In 1990, the State of Hawaii requested additional federal funding for what is defined by the State as Phase 3 of the HGP: Resource Verification and Characterization. In 1990, Congress appropriated $5 million (ref) for the State's use in Phase 3. Because Congress considered Phase 3 work essentially is "research" and not development or project construction, Congress indicated that this funding would not be considered a major federal action under NEPA that would typically require an EIS. However, because the project is

highly visible, somewhat controversial, and involves a particularly sensitive environment in Hawaii, Congress directed in 1991 that "... the Secretary of Energy shall use such sums as are necessary from amounts previously provided to the State of Hawaii for geothermal resource verification and characterization to conduct the necessary environmental assessments and/or environmental impact statement (EIS) for the geothermal initiative to proceed" (ref). In addition to this Congressional directive, the U.S. District Court of Hawaii (ref), in litigation filed by several environmental groups, ruled that the federal government must prepare an EIS for Phases 3 and 4 of the HGP before any further disbursement of federal funds to the State for the HGP.

1.2 PURPOSE AND NEED

The purpose of the HGP is to develop Hawaii's indigenous geothermal resource for the production of electricity. The State of Hawaii has declared that the HGP is needed to help the State reduce its heavy dependence on imported oil. Currently, the State uses petroleum for approximately 90 percent of its power production, which is the highest percentage usage of petroleum among the 50 states.

1.3 SCOPE

The full range of potential impacts of the proposed project and alternatives will be addressed in the HGP EIS. The environmental resource areas that have the potential for significant impact, and therefore those that will be analyzed in detail include land use, air quality, water resources, ecological resources, geologic issues, noise, health and safety, socioeconomic issues, cultural resources, and aesthetic visual effects. Further information on these topics and on other topics expected to be addressed in the EIS can be found in Section 3.3 of this working draft IP. A proposed outline for the HGP EIS that identifies the types of impacts to be addressed is presented in Appendix A.

2. PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

The proposed action is for DOE to partially fund Phase 3 of the HGP, as defined by the State in its 1990 proposal (ref) to Congress, using the funds, remaining from the $5 million Congressional appropriation for Phase 3 of the HGP after EIS expenditures. However, the EIS will address both Phases 3 and 4 as required by Congressional directive (ref) and U.S. District Court of Hawaii ruling (ref) (Sect. 1.1). Activities to be carried out in Phases 3 and 4 are described in Sect. 1.1.

2.2 ALTERNATIVES

The basic decision being considered by DOE is whether or not to partially fund Phase 3, as defined by the State, with the funds remaining from the $5 million Congressional appropriation after EIS expenditures. Under the no-action alternative, the federal government would not contribute funds to planned geothermal development in Hawaii; but this alternative would not preclude the continuation of the HGP using other sources of funding by the State or others

Other alternatives that will be considered are: (1) development of up to 100 MW of geothermal power for exclusive use on the Big Island, with no inter-island transmission cable (It would include other sources on other islands to make up the equivalent power and generation of the proposed projects); (2) alternative sites for geothermal development and construction of power plants within established geothermal resource subzones (GRSs); (3) alternative routes for transmission lines on land and in the sea; (4) alternative geothermal power generating technologies; (5) alternative submarine cable technologies; (6) alternative power production technologies, such as coal-fired; (7) renewable and

demand-side management (DSM) alternatives that would consider a mix of supply and demand options available to Hawaiian utilities and the State within the framework of integrated resource planning (IRP); (8) continued reliance on the existing mix of power generating technologies with emphasis on oil-fired power plants.

Although many alternatives were mentioned during the scoping process, only those alternatives deemed to be viable and reasonably foreseeable within the time frame of the proposed project will be considered. In general, the alternatives that will not be considered in this EIS were either anticipated to be not technically feasible within the project time frame (e.g. ocean thermal energy conversion) or technically feasible but extremely unlikely because of legislative or other impediments. As an example, the development of nuclear power in Hawaii is unlikely because of the statutory requirement for a 75% legislative affirmation of such an action (ref).

3. THE SCOPING PROCESS AND RESULTS

3.1 NOTICE OF INTENT

An Advance Notice of Intent (ANOI) regarding preparation of the HGP EIS was issued in the *Federal Register* (ref) by DOE on September 3, 1991. It announced the initiation of planning and scoping of the HGP EIS and solicited public input regarding scope and content of the EIS. DOE received 55 comment letters on EIS-related topics, which were considered in this working draft IP. These comments helped frame the content of the ANOI and were the stimulus for a series of information exchange meetings. DOE solicited further input at these meetings held during September, October, and November 1991, and March 1992. These meetings were conducted with federal, State, and local agencies, as well as with environmental, civic, Native Hawaiian, and public interest groups, in addition to utilities and geothermal developers (see Table 3-1).

On February 14, 1992, a Notice of Intent (NOI) was issued in the *Federal Register* by DOE to announce DOE's intent to prepare an EIS for Phases 3 and 4 of the HGP as defined by the State in its 1989 proposal to Congress. The NOI also announced that ten scoping meetings would be held in Hawaii from March 7 through March 16, 1992, to afford the public an opportunity to identify environmental issues and concerns related to the proposed project. The NOI also asked that written scoping comments, which were to be given equal weight with oral comments, would be received until April 15, 1992, for consideration in the IP.

TABLE 3-1
INFORMATION EXCHANGE MEETINGS

November 12, 1991 - Wailuku, Maui, HI (18)
- Blue Ocean Preservation Society
- Campbell Estate
- Coral Reef Foundation
- Kaupo Ranch
- Maui Tomorrow
- Pele Defense Fund
- Sierra Club

November 13, 1991 - Hilo, HI (35)
- Mayor's Advisory Group on Energy

November 13, 1991 - Pahoa, HI (23)
- Big Island Papaya Growers
- Big Island Rainforest Action Group With Malu Aina
- Citizens for Responsible Energy Development With Aloha Aina
- Greenpeace Hawaii
- Hawaii Island Geothermal Alliance
- Kapoho Community Association
- Lani Puna Gardens Association
- Pele Defense Fund
- Puna Community Council
- West Hawaii Sierra Club

November 14, 1991 - Honolulu, HI (9)
- Native Hawaiian Legal Corporation
- Pele Defense Fund

November 15, 1991 - Honolulu, HI (13)
- National Audubon Society
- Natural Resources Defense Fund
- Oahu Rainforest Action Network
- Rainforest Action Network
- Sierra Club Legal Defense Fund

March 6, 1992 - Pahoa, HI (7)
- Puna Geothermal Ventures (incl. site visit)

March 7, 1992 - Pahoa, HI (27)
- Native Hawaiian Organizations
- Pele Defense Fund

March 8, 1992 - Pahoa, HI (7)
- True-Mid-Pacific (incl. site visit)

3.2 SCOPING MEETINGS

Beginning on March 7, 1992, DOE held two scoping meetings at each of five locations in Hawaii, as indicated in Table 3-2. The public scoping meetings were held in compliance with CEQ regulations (40 CFR 1501.7) and DOE NEPA Guidelines (52 FR47664, December, 1987) and in concert with DOE's policy to facilitate opportunities for public involvement in the NEPA process. The purpose of these meetings was to assure adequate opportunity for public and government agency participation in developing the EIS scope by identifying the issues to be addressed, commenting on the proposed action, and suggesting alternatives to be analyzed. The public scoping meetings ended March 16, 1992. Copies of the meeting transcripts are available at DOE Reading Rooms and other locations identified in the *Federal Register* Notices. DOE has also prepared an extensive mailing list identifying parties which are participating in the EIS preparation. DOE has notified all interested parties by mail of the availability of the meeting transcripts. As shown in Table 3-2, about 170 people provided approximately 600 comments during scoping meetings. In addition, approximately 70 people submitted materials and letters to DOE during the scoping period (before the April 15, 1992, deadline). The majority of comments came from individuals. However, about 50 organizations, including environmental, public interest, and community groups, also participated by offering comments through representatives.

3.3 RESULTS OF SCOPING MEETINGS

The following discussion summarizes the comments raised during the scoping process, organized according to the issues raised. Table 3-3 indicates how many comments were received relating to each concern or issue. Examples of comments from which each issue was derived are provided, followed by how the EIS will address that issue. The discussion also identifies which issues DOE considers to be within the EIS scope.

Table 3-2 Scoping Meeting Locations, Dates and Number of Commenters/Comments

Location in Hawaii	Date	Commenters	Comments
Pahoa (Big Island)	March 7, 1992		
	Meeting 1	35	134
	Meeting 2	19	65
Wailuku (Maui)	March 9, 1992		
	Meeting 1	14	45
	Meeting 2	18	78
Kaunakakai (Molokai)	March 12, 1992		
	Meeting 1	14	27
	Meeting 2	16	40
Honolulu (Oahu)	March 14, 1992		
	Meeting 1	10	51
	Meeting 2	23	87
Kamuela/Waimea (Big Island)	March 16, 1992		
	Meeting 1	15	47
	Meeting 2	6	27
Total		170	601

3.3.1 Air Quality/HGP Emissions

Many commenters expressed concerns about atmospheric emissions from the geothermal wells and facilities-emissions that may occur during construction and operation of the proposed facilities, and during an accident. Bases on recent experience with geothermal development and accidents in Puna, commenters suggested a variety of adverse environmental effects that may arise from these operations. Of particular concern was the emission of hydrogen sulfide (H_2S) and other airborne pollutants and their effects on the health of nearby residents; several examples of ongoing effects were noted. The commenters believed that such effects are poorly understood and frequently underestimated.

Table 3-3. EIS issues and number of comments

Chapter 3 section number	Issue	Number of Comments	
		ANOI	NOI
3.3.1	Air Quality		48
3.3.2	Surface and Groundwater Resources		30
3.3.3	Geologic Concerns		88
3.3.4	Terrestrial and Aquatic Ecological Resources		79
3.3.5	Noise		18
3.3.6	Land Use		42
3.3.7	Health and Safety		67
3.3.8	Socioeconomics		73
3.3.9	Cultural Resources		82
3.3.10	Aesthetic Resources		40
3.3.11	Alternatives		70
3.3.12	Federal, State, and Local Government and Developers		74
3.3.13	Compliance with Environmental Regulations		12
Total			723

Examples of issues that were identified in the scoping process include:

- Effects on human health of acute exposure to H_2S
- Nuisance effects of H_2S
- Effects of emissions other than H_2S (e.g., radon, heavy metals, and silicate)
- Degradation of ambient air quality with regard to the concentrations of those pollutants for which ambient air quality standards exist (sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, lead, and suspended inhalable particulate matter)
- Validity of data regarding H_2S exposure and the validity of using standards for healthy workers as opposed to standards for the general population
- Sufficiency of air quality monitoring
- Effects on human health of cumulative and chronic exposure to H_2S and other pollutants (e.g., radon, heavy metals, and silicate)
- Global issues (acid rain and global warming)
- Effects of adverse meteorological conditions (air stagnation) on concentrations of pollutants that might affect human health.

The air quality section of the EIS will identify pollutant sources during drilling, construction, and operation of the geothermal power plant as well as potential sources of pollutants that may occur during a facility accident. Background levels of air pollutant concentrations must be added to estimates of pollutant concentrations resulting from the proposed action, and the results must be compared with the National Ambient Air Quality Standards (NAAQS) and state of Hawaii standards, including the recently passed State of Hawaii standard for H_2S (ref). Pollutant concentrations will be estimated using EPA-approved modeling codes. Prevention of significant deterioration of air quality will also be addressed in this EIS. It is possible to conform to the NAAQS and still be in violation of the standards for prevention of significant deterioration. The description of ambient air quality presented in the affected environment section of the EIS will consider cumulative emissions from existing geothermal sources and from regional sources such as the volcano. The USGS will characterize volcanic contributions to ambient air quality. Ongoing air quality monitoring (of existing conditions) will be discussed in the EIS. Any additional

monitoring of air pollutants resulting from the proposed action will be discussed. Where applicable, the EIS will discuss mitigation measures that can be used in the event of an exceedance of air quality standards. The Hawaii Department of Health (DOH), Clean Air Branch, will be the primary cooperating agency to determine background levels of air pollutant concentrations and existing emissions sources other than the volcano; there are no air quality agencies at the local level in Hawaii. DOE, through its cooperating agency relationships with the State of Hawaii, will obtain the necessary background data.

The EIS will address the impact of H_2S emissions during routine operations and during facility accidents; H_2S is one of 189 hazardous air pollutants specifically listed in the 1990 amendments (ref) to the Clean Air Act, and is also one of the 16 extremely hazardous pollutants listed in Title III, Section 301 (r)(3), of the Clean Air Act Amendments of 1990. The Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) H_2S exposure limits (in addition to the new State H_2S ambient air quality rule) will be presented and discussed in the EIS. Because H_2S is a major issue relevant to the proposed action, measures for abatement and mitigation will be considered in the preparation of the EIS.

Additionally, the EIS will discuss emissions during routine operations that may affect global air quality concerns. These include atmospheric emissions of CO_2 and other greenhouse gases.

Where not explicitly addressed above, scoping comments specifically brought forth by Region IX of the U.S. Environmental Protection Agency will be addressed in the EIS. Specific issues to be addressed include: background ambient air quality, nonattainment (if applicable), hazardous air pollutants, adverse meteorological conditions affecting air quality (e.g., stagnation), fugitive emissions from construction and operation, air quality monitoring, and noise (in a separate section).

The Hawaii Volcanoes National Park is designated a Class I area for the prevention of significant deterioration of air quality. Class I areas are designated to severely restrict the degradation of air quality, and specific standards for certain pollutants (nitrogen oxides, sulfur dioxide, and airborne particulate matter) apply. The effects on the Class I area will be addressed in the EIS.

Air quality related values such as visibility degradation and odors will be addresses in the EIS. These values are of particular importance in national parks and other Class I areas.

The air quality section of the EIS will not address the impact of airborne releases on soil, water, vegetation, and other ecological resources. Additionally, human health impacts from air pollutants will not be discussed in the air quality section. All of these topics will be specifically addressed in other sections of the EIS.

3.3.2 Surface and Groundwater Resources

Commenters thought that well drilling, resource utilization, and well reinjection activities may adversely affect water resources. A common concern was the impact of airborne emissions deposited on the catchment water systems used by nearby residents for drinking water supplies. Airborne emissions consist of geothermal fluids containing sulfides, arsenic, boron, mercury, lead, and benzene as well as other hazardous and toxic substances whose presence could render catchment water systems unfit for human consumption.

Commenters also noted the complex hydrogeology of the region and the importance of area aquifers. Hawaii's groundwater supplies consist of (1) a freshwater lense (referred to locally as basal water) floating on the underlying saltwater in a highly permeable, porous aquifer, and (2) groundwater reservoirs impounded by underground, volcanic dikes.

Examples of issues and information requests that were identified in the scoping process include:

- Leakage from production and injection wells into aquifers caused by well casing failures
- Impacts of other accidents, such as well blowouts on water resources
- Other effects of reinjection, such as thermal and chemical contamination
- Impacts on drinking water quality of nearby, affected catchment systems and deep wells

- Transport of contaminants from HGP-related wastes and effects of brine impoundments, both into underground sources of drinking water
- Erosion control during construction and operation of the plant
- Management of point and nonpoint contamination sources
- Groundwater monitoring system
- Mitigation plan to halt emanating groundwater contamination detected by groundwater monitoring system
- Complete geothermal fluid characterization
- Map of nearby drinking water wells that could be affected by construction and operation of the plant
- Spill prevention, containment, and mitigation methodology
- Source of water for well drilling during construction and well quenching during plant operation
- Well casing and hydrologic monitoring plan for both production and reinjection wells

Analyses will be performed to evaluate the environmental impacts associated with the above issues. Studies will be carried out to obtain information requested above that is not available in the open literature.

The State of Hawaii is considering the status of its water quality designation in the geothermal subzone beneath the District of Puna. All analyses of environmental impacts will be based on the water quality designation in effect at the time of writing of the EIS.

Cooperating agency involvement will include the State of Hawaii, the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the County of Hawaii. The results from a surface water and groundwater survey that will be performed by the U.S. Geological Survey will be included in the EIS.

The status of existing surface and groundwater resources and the effects of the HGP on these resources will be assessed in the EIS. Existing hydrogeological data for the HGP site and its surrounding environs as well as other available background information will be used to assess the potential for contaminant transport and contamination. Impacts of routine operations and potential accidents also will be evaluated. Use of this information will provide the basis for the health and ecological assessments discussed in Sects. 3.3.4

and 3.3.7, respectively. Underground injection regulations promulgated by both the State of Hawaii and EPA will be used in the assessment of groundwater impacts.

Effects on water resources will be evaluated by comparing impacts that occur during normal plant operation against (1) impacts from accidents that would be mitigated by safety systems such as shutoff valves installed in the plants, and (2) impacts from severe accidents that would overwhelm safety features designed into the plants. These analyses will focus on temporary uncontrolled well venting during loss of cable, accidental well blowouts, and underground reinjection of geothermal fluids. This approach will place upper and lower bounds on potential impacts to water resources and will demonstrate that impacts attributable to reasonable design accidents are reduced to as low as reasonably achievable (ALARA) levels by installed safety features.

3.3.3 Geologic Issues

The location of geothermal facilities on the site of an active volcano concerned many commenters. They indicated that the potential for seismic disturbances and lava flows at the geothermal facilities increased the risk of accidents and created conditions that cannot be addressed by the current state of technology. A geologically active and complex region, they said, is not suitable for industrial facilities. The rugged and unstable terrain of the marine environment in which the undersea cable would be placed also was noted as a geologic issue.

The principal issues identified in the scoping process were:

- Hazards of development in a seismically and volcanically active area
- Potential for induced seismicity from withdrawal and reinjection of geothermal fluids
- Potential for geothermal-associated subsidence from withdrawal and reinjection of geothermal fluids
- Resource depletion; reliability of geothermal power production
- Geothermal fluid withdrawal and reinjection effects
- Effects on soils
- Comparison of HGP site with other geothermal development sites (e.g., Iceland)

- Reliability of the cable in harsh and unstable marine environment
- Potential for lava flow hazards
- Potential for tephra hazards (airborne lava)
- Potential for uplift and subsidence hazards from volcanic activity
- Potential tsunami hazards
- Potential undersea slide hazards and turbidity current hazards

For both the HGP and the transmission/cable system, geologic issues will be treated in detail in the EIS. The volcanically and seismically active nature of the proposed development area raises a number of geologic issues that require an objective evaluation. Site studies and available literature will provide data; these data should provide a basis for assessing several geologic issues such as subsidence and withdrawal/reinjection effects. The geologic suitability of the site for HGP facilities also will be assessed.

Geological literature of the Hawaiian Islands is extensive. The U.S. Geological Survey and DOE are in consultation about appropriate levels of analysis for natural hazards (earthquakes and volcanism) and for identifying the most appropriate information to be used in analyses of geologic issues. The potential for damage to geothermal facilities by fresh lava flows will be assessed as well as effects of earthquake-induced phenomena such as excessive ground motion, surface rupture, liquefaction, and landslides. Environmental impacts of accidental release of geothermal fluids will be assessed (see Section 3.3.2). The effects of prolonged withdrawal and reinjection of geothermal fluids during plant operations also will be analyzed (see Section 3.3.2). If possible, reservoir engineering characteristics will be used to predict the nature of induced seismicity, subsidence, and geothermal reservoir depletion. These analyses would depend on the availability and appropriateness of existing models. Analysis of routine operational impacts would be based on the assumption that automatic shut-off valves and blowout preventers function as intended and that other reasonable safety features (such as flexible joints between steam gathering lines on the surface and well heads) are included. Analysis of accident driven impacts will assume that pipeline-well head connections fail and that automatic shut-off valves also fail or that a blowout preventer on a drilling well fails, leading to uncontrolled venting of geothermal fluid. The impact of damaging an undersea transmission cable also

will be assessed. Scenarios in which an undersea cable may be severed include strong ocean currents, submarine erosion by strong ocean currents, and submarine landslides (turbidity currents) generated by earthquakes and submarine erosion.

Soils in the Puna District and on transmission line rights-of-way will be described from existing U.S. Soil Conservation Service (USSCS), or equivalent, surveys. Construction, operational, and accident-related impacts to these soils will be assessed. The USSCS will be consulted.

Well completion designs and erosion and sedimentation control plans will be assessed for compliance with existing State regulations. In addition to the USGS, this assessment will require consultation with the Hawaii Department of Land and Natural Resources, the Division of Water Resources Management, and Department of Health. County governments will be consulted with respect to erosion and sedimentation control plans.

3.3.4 Terrestrial and Aquatic Ecological Resources

A recurring concern expressed by commenters was the effect of geothermal development and cable construction on terrestrial and aquatic resources. The uniqueness and value of the Wao Kele O Puna rain forest was cited as an overriding concern. Commenters suggested that comprehensive surveys of rain forest species need to be compiled and evaluated. Moreover, they thought that the EIS should fully investigate the potential short- and long-term impacts of the HGP to pristine environments, such as the rain forest, the southeast coast and Hana districts of Maui, much of Molokai, the marine environment and other locations. These data gathering activities will be a significant part of the early activities in preparing the EIS.

The principal issues identified in the scoping process include:

- Deforestation and loss of biodiversity
- Impacts of geothermal development and transmission right-of-way on habitat
- Effects of atmospheric emissions, liquid effluents, waste disposal and impoundments, and noise on ecological resources in the Puna district
- Perceived impacts of EMF on fauna along transmission corridors

- Impacts of cable on marine species, including humpback whales, rays, skates, and sharks
- Impacts on populations of threatened and endangered species and critical habitat
- Effects of operation of geothermal facilities on agricultural crops
- Loss or disturbance of wetlands

Terrestrial and aquatic ecological resources will be described in the EIS, and the impacts of HGP development, construction, and operation on the resources, including wetlands, floodplains, and species and areas of special concern, will be assessed. Assessment will draw upon existing literature and studies conducted by FWS and COE including a comprehensive biota survey (e.g., forest bird and vegetation studies), a hoary bat survey, a native rain forest ecostem analysis, and wetland delineations. The need for additional data collection is currently being evaluated in consultation with DOE, FWS, COE, and others. Any deficiencies in the information base required to prepare the EIS will be noted and supplemented if judged appropriate. Depending on the results of the assessment and the relationship to proposed Alternatives, appropriate mitigation action plans will be developed in the preparation of the EIS.

The impacts of the proposed development on the terrestrial and aquatic ecosystems in general and on the rain forest, wetlands, cave ecosystems, vegetation, bird species, threatened and endangered species (both in the rain forest and along the transmission corridors), invertebrates, and ethnobotanical species in particular will be addressed in the EIS. Results of studies approved and conducted in support of the EIS will be incorporated into the EIS. Potential impacts of invasion of alien species into the rain forest as the result of geothermal development and power transmission will be addressed. A Geographic Information System (GIS) analysis, built on existing data bases, will be used to address pertinent issues identified during preparation of the EIS. These issues include (1) whether geothermal development will accelerate invasion of alien species into natural and disturbed areas, (2) whether geothermal development will contribute to the loss of native flora and fauna, (3) if roads and well pads can be located within the rain forest to minimize invasion of alien species and to minimize impacts on native vegetation and habitats, and (4) if there are changes in vegetation communities as a result of natural

disturbances. Existing and updated vegetation and bird survey data can be overlaid to determine the distribution of required habitat for different bird species and can be used to recommend areas for preservation and those more suited for potential development.

The extent and type of wetlands within all land areas potentially involved in the geothermal resource area and along transmission corridors will be delineated and significance ascribed by COE in consultation with DOE, SCS, USGS, FWS. The COE will use the 1987 COE Wetland Delineation Manual to delineate wetlands. Wetlands maps and supporting data will be provided to DOE for the purpose of performing wetlands assessments based on the practicable alternatives analysis in accordance with Clean Water Act [Sect. 404(b)(1)] guidelines for dredging and filling. When wetlands are identified, a detailed assessment of the potential impacts on the wetland ecosystem will be made and approaches for minimizing or avoiding wetland involvement will be discussed. The assessment will include potential impacts on wetland functions, including water quality, hydrology, vegetation composition and structure, habitat for threatened and endangered species, and biological diversity and will become an appendix to the EIS.

The potential for impacts to threatened and endangered species and wetlands are required analyses in the EIS. During the EIS process the FWS, the NMFS, as well as the State Department of Natural Resources will be contacted for information and consultation under Section 7 of the Endangered Species Act and the Marine Mammals Protection Act (see Table 4-1).

The EIS will include an evaluation of the potential biological effects on marine life of electric and magnetic fields produced by the submarine cable. At least four possible cases will be evaluated. The first case considers fields produced during normal operation of the cable system including typical static magnetic fields and electric fields as well as induced fields which may occur during transients and line loading changes. Case two occurs temporarily after damage to one or more of the cables, and is characterized by higher than normal current densities in the area around the cable damage. The third case involves deliberate transmission of the system return current through the ocean in emergency situations when only one cable is functional. This technique has been used routinely in other submarine DC power transmission systems. Case four involves staged development in which there could be AC transmission between the islands of Hawaii and Maui.

Certain marine animals (e.g. sharks) have specific sensory organs that aid in navigation and foraging and that detect extremely weak electric or magnetic fields. Behavior patterns may be affected by transmission line fields. Calculations of the fields will be provided in the EIS followed by a review of available knowledge regarding the effects of the these fields on sensitive marine life and if possible an evaluation of expected impacts. In addition the potential effects of EMF from the transmission lines on terrestrial fauna will be evaluated.

3.3.5 Noise

Some commenters pointed out that well drilling and venting from geothermal development and operations will create noise. Well drilling and venting from current local geothermal developments were often cited as activities that produce intense noise. Extraordinarily quiet conditions currently prevail in the area where noise impacts resulting from the proposed activity are expected.

Examples of noise issues that were identified in the scoping process include:

- Occupational and public health impacts (including psychological impacts) of noise from drilling, construction, and venting operations, and possible associated exceedances of OSHA/NIOSH standards
- Effects on terrestrial flora and fauna.

This section of the EIS will use existing data provided by qualified professionals specializing in noise characterization to describe and assess noise. Noise measurements will include ambient levels as well as noise resulting from existing geothermal activities (drilling and operating). Consultants will be used, as necessary, to develop noise contours. The noise measurements will include peak levels and energy-averaged levels. Noise from both normal operation (including transients) and upset conditions will be described.

The EIS will assess and evaluate potential impacts of noise to the nearest residential population, and to terrestrial species. A section will be prepared which describes noise-induced hearing loss. The levels associated with this effect will be compared with expected contours. Compliance with applicable public and occupational standards for

nuisance related noise, including psychological effects, will be addressed in the EIS. Noise-related annoyance and possible cardiovascular effects to residents living near well-drilling or other geothermal activities will be addressed. Noise abatement and mitigation measures (e.g., rock mufflers) will also be addressed and assessed.

3.3.6 Land Use

Commenters raised land use concerns, especially those pertaining to conflicts between residential use and geothermal development. Land-use issues related to Native Hawaiian concerns are discussed in Sect. 3.3.9.

Examples of issues that were identified in the scoping process include:

- Incompatibility of HGP with existing nearby residential, agricultural, and military land uses and lands in conservation areas and the Hawaii Volcanoes National Park and other preserve land areas
- Loss of unique land resources, such as the Wao Kele O Puna rain forest, to HGP and its associated features (transmission lines, roads, support facilities)
- Incompatibility of transmission line corridors with existing and planned land uses

Land-use issues will be addressed in multiple sections of the EIS. Agriculturally and ecologically related land-use issues will be discussed under the "land use" heading. Land use issues that affect Native Hawaiian interests and culture will be discussed separately (see Sect. 3.3.9) and land use issues related to economics will be discussed in the socioeconomics sections of the EIS (see Sect. 3.3.8). To assess potential land use impacts, the EIS will identify existing and planned land uses in the proposed vicinity of HGP facilities, and transmission corridors, and determine if and to what extent the construction and operation of the HGP would be incompatible with or destructive to those land uses. Cooperating agencies that will provide information about existing and planned land uses include the Counties of Hawaii and Maui (Planning Departments) and the State of Hawaii (e.g., the Department of Land and Natural Resources and Office of State Planning). In

particular, County Community Development Plans for affected counties will be consulted and considered.

3.3.7 Health and Safety

Participants in scoping expressed concern about health risks to workers and the public from routine operations and accidents.

Examples of issues that were identified in the scoping process include:

- Health and safety impacts of routine emissions (via air and water pathways)
- HGP accidents–effects on human health
- Cable accidents
- Effects of well venting and possible blowouts
- Occupational safety
- EMF effects
- Psychological effects of HGP development, construction, and operation
- Hazardous wastes and other materials

The HGP EIS will address health and safety issues as they relate to both operations and accident conditions. The basic methods for addressing these situations are similar. For public exposures first step is to identify the materials that will be emitted to air or water. These would include radon and daughters, H_2S, heavy metals, silicate and the entire inventory of gaseous and particulate emissions to the air or water. The next steps are to consider the various transport pathways, such as inhalation, food, and drinking water, and then calculate intake either on a continuous basis or under accident (episodic) conditions. These intakes then are converted to health effects via dose-response relationships, or compared with allowable intakes or other indices (e.g., State ambient air quality standards for the H_2O). In addition, potential occupational exposures will be evaluated, to the extent possible, with respect to OSHA and NIOSH regulations.

Of special concern are the many hazardous materials, including waste which are present at geothermal sites. To the extent possible, these will be listed along with applicable regulations. Drilling muds and waste ponds represent a special source of possibly toxic materials and they may pose a special waste disposal situation. To the extent possible, the contents of such muds and ponds, will be characterized so that any potential health effects issues can be quantified and future waste disposal requirements can be identified.

Public concern over the possible health effects of EMFs associated with power generation and transmission has increased sharply in recent years. The EIS will include an evaluation of EMFs near the power generation facilities, along the transmission line right-of-ways, at the rectification stations, and at ocean entry and exit points. Safety issues associated with ocean return currents during single cable operation will also be evaluated. In addition, a section will be prepared which summarizes the most recent scientific understanding of the possible long-term effects on humans.

To the extent possible for accidents, materials-selection and/or design-related will be bounded. Accidents could result from material phenomena or from a variety of human factors including operator error, material and design choices. Where information is deficient, a deterministic approach will be used. Because the site is geologically active, major potential accident initiators are natural in origin and include earthquakes, and volcano eruptions. The quantities of the primary materials released such as radon, H_2S, toxic heavy metals and their effects will be contrasted with the quantities and effects that the natural events initiate such as well head failure.

The HGP EIS will include a qualitative discussion of potential psychological effects and their manifestations (e.g., people moving out of their residences due to geothermal activities) resulting from factors related to the construction and operation of geothermal facilities (e.g., noise, odor, night lights). Influences on sleep deprivation by fear, and anxiety will be evaluated and the effects of frequent evacuation will be assessed.

The HGP EIS will describe existing emergency preparedness plans in the Puna District. It also will address emergency preparedness needs that may arise from the proposed project. Emergency preparedness will be addressed in light of the State of Hawaii's H_2S rule, the Federal Emergency Management Agency's (FEMA) guidance, and

the requirements of the Superfund Amendments and Reauthorization Act (SARA) Title III, as implemented by EPA. Issues related to visual impairment during emergency situations will be discussed.

3.3.8 Socioeconomics

Socioeconomic concerns were expressed by many commenters. Scoping participants noted that the potential social and economic costs and benefits of geothermal development are complex and need to be evaluated in detail. Socioeconomic concerns ranged from the local effects of HGP (e.g., property values) to more general concerns (e.g., economics of Hawaiian tourism and industry).

Examples of the issues that were identified in the scoping process include:

- The total cost of the HGP from inception to decommissioning and rehabilitation
- Attracting industrial development to Hawaii
- Effects on nearby property values
- Increasing electric rates (because of HGP's high cost and questionable reliability) and tax changes
- Increasing tourist developments and economic dependence on tourism
- Impacts of the HGP on life styles of the general population, specifically on Native Hawaiians
- The cost of cable or facility failure once geothermal energy provides a significant proportion of Hawaii's energy needs
- The need for an accurate cost estimate of geothermal construction and operation
- Financial reimbursement to nearby residents due to HGP
- Economic impacts on agriculture, commercial fisheries, aquaculture, and tourism

The EIS will assess several of these and other potential socioeconomic issues, including: 1) HGP-related population changes and subsequent impacts to employment, housing, public services, land use, and recreation and tourism; 2) the possibility of the

HGP providing power for increased urbanization, industrialization, and tourism; and 3) the political and social conflict generated by the HGP.

The EIS will assess socioeconomic impacts by examining the impacts of constructing and operating existing geothermal projects and other large energy-related facilities and projecting the HGP's impacts based on past experiences. The socioeconomic impact assessment will rely heavily on data from local planning agencies and the State of Hawaii.

Some concerns raised by commenters are beyond the scope of the EIS. Issues that will not be addressed in the socioeconomic impact assessment include the economic impacts of HGP construction and operation on marijuana growers and the financial impacts of the State's promotion and litigation of the HGP.

3.3.9 Cultural Resources/Native Hawaiian Concerns

Many speakers at the public meetings requested that the EIS consider the Native Hawaiians and their rights, religion, and culture. Many people expressed the belief that geothermal development would desecrate the volcano goddess Pele, and recommended that the EIS examine potential impacts of the HGP on Native Hawaiian lifestyles and cultural and religious practices.

Examples of the issues that were identified in the scoping process include:

- Potential desecration of Pele, the volcano-nature deity, and impaired ability to observe Native Hawaiian religious practices associated with Pele; interrupted generational continuity in the training of young persons in traditional religious and cultural practices
- Loss or desecration of religiously, spiritually, culturally, and socially unique habitats, land forms, resources (e.g., archaeological sites and artifacts; atmospheric signs such as rainbows), and species
- Loss of racial identity

- Reduced access to traditional coastal trails and to areas important for subsistence gathering and medicinal use of plants; loss of gathering, fishing, and water rights, and loss of healing places
- Reduced contact with fish, birds, and other wildlife identified as 'aumakua (deified ancestors); loss of traditions rooted in aloha 'aina (respect and love for the land)
- Impaired religious and other cultural uses of surface and subsurface waters located at or near the geothermal resource
- Loss of access to and use of Native Hawaiian Homelands and ceded lands on several of the islands
- Alteration of the traditional rural physical setting and landscape
- Compliance with the American Indian Religious Freedom Act , the National Historic Preservation Act of 1966, and other pertinent state and federal legislation (see Table 4-1)
- Effects of geothermal development on archaeological resource identification, evaluation, and protection; increased unauthorized access to archaeological sites and areas important to traditional culture, which could lead to their alteration or destruction
- Confidentiality of Native Hawaiian practices and religiously significant sites, including heiaus (places of worship) and burial sites in caves, cliffs, lava tubes
- Effects on subsistence lifestyles
- Impact on State constitutional Native Hawaiian legal rights and Common Law rights of 1892
- Impact on Native Hawaiian family and community life
- Impact on intergenerational linkages to ancestral lands and cultural/historic sites
- Impact on quality of life, changes in mental/cultural health, and impact on Native Hawaiian identity and pride

To assess specific cultural resource and Native Hawaiian concerns, the EIS will employ an archaeological survey of the main project area in the Puna District and additional reconnaissance and inventory surveys on all affected islands, of geothermal resource subzones, transmission line corridors and access roads, and land-sea transition points along

submarine cable routes. In addition, the EIS will utilize a Native Hawaiian cultural resource survey which may involve archival research and indepth ethnographic and ethnohistorical description and analysis of those aspects of Native Hawaiian culture covered by this project. The survey work needed for this assessment will be conducted by consultants; however, the Hawaii State Historic Preservation Officer, the Office of Hawaiian Affairs, the Office of Hawaiian Homelands, the National Park Service, the President's Council on Historic Preservation, and the Hawaii State Department of Health, Environmental Project Section will be consulted as important sources of information and guidance in undertaking the required studies. These archaeological and cultural resource surveys will provide the basis for compliance with pertinent federal legislation, including the National Historic Preservation Act of 1966 (as amended), Sections 106 and 110; the American Indian Religious Freedom Act of 1978 (amendments proposed); and the Native American Grave Protection and Repatriation Act of 1990. Pertinent state legislation includes Hawai'i Revised Statutes, Chapter 6E; and State Act 306 concerning historic preservation and protection of burial sites, respectively.

Some aspects of Native Hawaiian issues are beyond the scope of the EIS; these include, for example, the potential loss of racial identity. Other issues will be addressed only to the extent that they relate clearly to impacts generated by HGP. For example, a compilation of litigation involving Native Hawaiian claims aside from those directly related to HGP is beyond the scope of the EIS. However, DOE intends to consult and cooperate with Native Hawaiians through mutually recognized expert consultants and through recognized organizations (including the Office of Hawaiian Affairs and Hui Malama I Na Kupuna O'Hawai'i Nei) to ensure that the EIS accurately reflects to the extent practicable the concerns and issues tht Native Hawaiians regard as significant. In addition, DOE will promote wherever possible community access to the results of cultural studies. To the extent possible, consultations on these surveys will extend directly to affected Native Hawaiian communities.

3.3.10 Aesthetic Resources

Impacts to aesthetic resources were a concern for several commenters. They thought the EIS should address the aesthetic impacts of HGP on all islands, including impacts to natural and agricultural landscapes, beaches, and recreation areas.

Examples of the issues that were identified in the scoping process include:

- Visual impacts of clearing of the Wao Kele O Puna rain forest
- Visual impacts of transmission lines, particularly in established scenic areas and near park lands and preserves
- Visual impacts of an industrial facility in a residential and/or rural environment
- Aesthetic degradation of the Puna District because of HGP-related noise, odor, and night lighting
- Proximity of HGP facilities to Hawaii Volcanoes National Park in consideration of Air Quality Related Values under the Clear Air Act

The EIS will identify and describe important aesthetic resources in the vicinity of HGP facilities, and will assess the impacts of the proposed project on those resources. The assessment will involve an aesthetic resources survey and analysis conducted by professional consultants specializing in landscape architecture and aesthetic impact analysis. These consultants will contact local planning agencies and tourism boards for information and assistance in preparing the aesthetic resources survey and analysis.

3.3.11 Alternatives

Commenters suggested that there were several alternatives to the proposed HGP that should be addressed in the EIS. Examples of issues raised include:

- Development of up to 100 MW geothermal power (without inter-island submarine cable) for use on the Big Island.
- No-action alternative (i.e., DOE does not partially fund Phase 3)

- Economics of geothermal power compared with other reasonably foreseeable alternatives
- "Environmentally and economically preferable" alternative sources such as solar, wind, biomass, and others
- A mix of supply options, conservation, and demand-side management analyzed in an integrated resources planning context
- Use of petroleum byproducts (from petroleum processing for transportation fuels) for power production given the need to reduce Hawaiian dependence on imported oil
- Various HGP designs and configurations, including alternative facility locations away from residential areas
- Use of coal-fired generation
- Alternative cable (overland and submarine) routes
- The need for new power production facilities defined through integrated resource planning assessments

Alternatives to the proposed DOE action (partially funding Phase 3) and reasonably foreseeable actions by others (such as Phase 4, the State's proposed construction and operation of HGP) will be addressed in the EIS. These alternatives will include the no-action alternative of not partially funding Phase 3. In addition, reasonable alternatives within the proposed HGP, both supply and non-supply, as well as design and location alternatives will be considered.

The HGP will be evaluated to determine which alternatives have the potential to achieve similar objectives. The main emphasis will be in determining the proposed HGP's contribution to meeting power generation needs and Hawaii's energy policy goal of reducing reliance on imported oil. This determination will be based in part on projections of electric generation requirements and plans to meet these requirements.

Alternatives will be considered: alternatives associated with the submarine and overland transmission cable routes and alternatives related to electric power generation. Alternatives to the proposed transmission system will include: various overland and submarine cable routes, solid dielectric or oil-filled submarine cables, operation at either high voltage AC or DC, and alternative methods of land-sea transition. Each of these

alternatives will be evaluated based on their economic and technical viability, and the potential environmental impacts of each will be discussed.

Alternatives to the proposed 500 MW geothermal development will include various power generation strategies including alternative geothermal sites and power generating technologies. The no-action alternative will be defined as continued reliance on the existing generating mix (which is predominately oil-fired capacity with some renewables) to meet the equivalent amount of power associated with geothermal development. The alternative of coal-fired capacity will be considered. A mix of renewable alternatives, including biomass, solar thermal, photovoltaic, small-scale hydro, and conservation/demand-side management (DSM), including solar hot water heating systems, will be examined on an island-by-island basis in the context of integrated resources planning.

Alternatives that provide for geothermal generation to be used only on the Big Island with no submarine cable are: 500 MW for replacement of existing oil generation and to supply new commercial or industrial development on the Big Island; or approximately 100 MW of geothermal capacity for oil replacement only. The definition of these alternatives will consider the State of Hawaii and utility plans, and/or projected needs for generating power on the Big Island.

The alternatives will be evaluated by first screening them for technical feasibility, i.e., does the resource exist and is it technically feasible to develop it in the same time-frame as the HGP? If the alternative is technically feasible, its potential environmental impacts and economic costs will be evaluated and compared to those of the HGP.

The basis of the economic evaluation will be a comparison of the discounted valued of the life-cycle costs of geothermal to a configuration of alternatives that would provide equivalent power and generation (or an equivalent increase in energy efficiency and DSM) over the expected life of the geothermal resource. Cost estimates of alternatives will be based on the best available information with special consideration of cost factors affecting Hawaii. Alternative resources, power generating plants, DSM resources, and renewable energy options will be compared in an integrated resource planning context. This assessment will be conducted using available data and studies from the State of Hawaii, local utilities, DBED, and others, and will be coordinated with Hawaii's integrated resource planning process that is currently underway.

Uncertainty about capital costs, energy costs, economic risks, and other factors will be incorporated through sensitivity analyses. Alternatives to the HGP will be evaluated through the simulation of alternative resource plans using production cost modeling. The effect of alternatives on Hawaii's dependence on imported oil will also be explicitly examined. This examination will look at the use of imported petroleum, its association with petroleum processing residuals used for power production, and how reduced use of oil for electricity production would affect Hawaii's dependence on petroleum imports. The need for power production facilities will also be evaluated. The effect on environmental resources that are being considered for the proposed action will be considered for all viable alternatives.

3.3.12 Federal, State, and Local Government and Geothermal Developers

During the public scoping process, participants questioned the credibility of some organizations involved in the development of the HGP. They suggested involvement of non-geothermal affiliated firms during preparation of the EIS to improve credibility.

Examples of the issues that were identified in the scoping process include:

- Lack of governmental concern for citizens' rights, health, and welfare
- Lack of due process in HGP-related litigation
- Dismissal of public concerns by government officials
- Collaboration between government and geothermal developers
- Powerlessness of citizens to influence government decisions on HGP
- Competence of government employees and geothermal developers

These issues will not be addressed explicitly in the EIS, but will be a part of the overall EIS process. DOE recognizes the importance of independent oversight and public involvement in activities to build confidence and trust, and will continue to make information available to the public and respond to public comments.

For the HGP EIS, DOE held ten public scoping meetings (two a day at five locations) and provided a public comment period. Transcripts from these meetings were placed in

the HGP EIS reading rooms for public review. In addition, information exchange meetings and native Hawaiian meetings were held (see Table 3-1). This draft IP is being made available for public review and comment. Also, an interactive workshop will be held to receive comments and suggestions on the draft IP from all cooperating agencies. To encourage public involvement, *Federal Register* notices, press releases, and local advertisements have been used to publicize activities. DOE will continue to publicize public participation opportunities.

3.3.13 Environmental Compliance Regulatory Issues

Commenters thought that the EIS should review all applicable federal, State, and County rules, regulations, and statutes, including NEPA, OSHA requirements, the National Historic Preservation Act, the American Indian Religious Freedom Act, the Endangered Species Act (including Section 7 consultation), and the Public Utilities Regulatory Policy Act, and other (see Table 4-1). Commenters also thought that the EIS should include a review of regulatory issues in light of the major changes that have occurred during the course of the HGP.

Examples of the issues that were identified in the scoping process include:

- Federal, State, and local permit compliance
- Affect of past and current litigation on geothermal development
- Apparent violations of environmental laws by geothermal developers
- Inadequate monitoring for compliance with emissions standards
- Role of State and local enforcement agencies

The HGP will be required to comply with all relevant federal, State, and local regulations and legislation. The EIS will list and describe the federal, State, and local laws and acts that pertain to HGP, and will assess HGP impacts against the standards associated with those laws. For example, National Ambient Air Quality Standards and State of Hawaii air quality standards for H_2S will be used in the EIS assessment of HGP air quality impacts.

4. AGENCY CONSULTATIONS

A partial list of agencies that will be consulted during the EIS process are listed by subject area and agency in Table 4-1. This list will be revised and expanded if necessary in consultations with cooperating agencies.

4.1 COOPERATING AGENCIES

As part of the scoping process, DOE invited other federal agencies to participate in the EIS preparation as cooperating agencies. Cooperating agency roles and responsibilities in the EIS process, defined in the NEPA regulations, include participation in the scoping process, developing information, preparing environmental analyses, providing technical reviews, and lending staff support. The Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Geological Survey, National Park Service, National Marine Fisheries Service, State of Hawaii, County of Maui, and County of Hawaii have agreed to be cooperating agencies on the HGP EIS. Memoranda of Understanding are being negotiated by DOE and each cooperator. Details of cooperating agency studies and/or assessments are currently under review. Discussions are underway to determine the type and degree of cooperating agency involvement.

4.2 OTHER FEDERAL AND LOCAL AGENCIES AND ORGANIZATIONS

While preparing the HGP EIS, DOE will request consultations and conduct reviews with other federal agencies and Native Hawaiian organizations that do not have "cooperating" status as defined by CEQ. Other federal agencies have regulatory and environmental responsibilities. In particular, EPA, United States Navy, United States Coast Guard, Soil Conservation Service, Department of Interior, and Department of Transportation have been identified for such consultation. These regulations and responsibilities will be addressed in the EIS.

Table 4-1
Agency Consultations and Government Agency Permit Consultation List

Subject Area	Legislation	Agency
Endangered species	Endangered Species Act of 1973, as amended; state laws	U.S. Fish and Wildlife Service, State agencies
Migratory birds	Migratory Bird Treaty Act	U.S. Fish and Wildlife Service
Archaeological, historical, and cultural resource preservation	National Historic Preservation Act of 1966; Archaeological Resources Protection Act; Antiquities Act; American Indian Religious Freedom Act; and Native American Grave Protection and Repatriation Act	State Historic Preservation Office, President's Advisory Council on Historic Preservation, Native Hawaiian Groups, Office of Hawaiian Affairs
Discharge of pollutants to water	Clean Water Act; Safe Drinking Water Act	U.S. Environmental Protection Agency, State agencies
Work in navigable waters of the United States	Section 404 of Clean Water Act; Rivers and Harbors Act	Corps of Engineers
Prime and unique farmlands	Farmland Protection Policy Act of 1981	Soil Conservation Service
Floodplains	Executive Order 11988; Fish and Wildlife Coordination Act	Corps of Engineers, U.S. Fish and Wildlife Service, State agencies
Wetlands	Executive Order 11990; Fish and Wildlife Coordination Act; Section 404 of Clean Water Act	Corps of Engineers, U.S. Fish and Wildlife Service, State agencies
Water body alteration	Fish and Wildlife Coordination Act	U.S. Fish and Wildlife Service, State agencies
River status	Wild and Scenic Rivers Act; Anadromous Fish Conservation Act; Hanford Reach Study Act	U.S. Department of the Interior
Air pollution	Clean Air Act	U.S. Environmental Protection Agency, State and local agencies
Water use and availability	Water Resources Planning Act of 1965; Safe Drinking Water Act; others	U.S. Environmental Protection Agency, Office of Water Policy, State agencies
Noise	Noise Pollution and Abatement Act of 1970; Noise Control Act of 1972	U.S. Environmental Protection Agency, State agencies
Siting and planning	State siting acts; County zoning regulations	State and County agencies
Waste management and transportation	Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act and the Hazardous and Solid Waste Amendments of 1984; Comprehensive Environmental Response, Compensation and Liability Act; Emergency Planning and Community Right to Know Act	U.S. Environmental Protection Agency, U.S. Department of Transportation, State agencies

Table 4-1 (continued) Government Agency Permit Consultation List		
Permit	**Agency and Permits**	**Cross References of Related Permits/ Permits Delegated to Other Agencies**
Department of Land and Natural Resources		
DLNR 1	Ocean Waters Construction Permit	NOAA 1, CG 1, CG 2
DLNR 2	District Boundary Amendment	
DLNR 3	Changes in Zoning	
DLNR 4	Forest Reserve Special Use Permit	
DLNR 5	Forest Reserve Access Permit	
DLNR 6	Entrance to Wildlife Sanctuary	
DLNR 7	Transporting Permit	
DLNR 8	Permit to Enter Closed Watershed	
DLNR 9	Natural Area Reserve Special Use Permit	
DLNR 10	Historic Preservation Review	COE 1, COE 5
DLNR 11	Use of State Land Including Submerged State Lands	NOAA 1, CG 1, CG 2
DLNR 12	Conservation District Use Application	
DLNR 13	Water Use Permit Within Water Management Areas	
DLNR 14	Stream Channel Alteration Permit	
DLNR 15	Stream Diversion Works Construction or Alteration Permit	
DLNR 16	Well Construction or Pump Installation Permit	
DLNR 17	Geothermal Resource Mining Lease	
DLNR 18	Dams and Reservoirs Construction Approval	COE 2
DLNR 19	Geothermal Exploration Permit	
DLNR 20	Geothermal Resource Subzone Designation	
DLNR 21	Geothermal Plan of Operations	
DLNR 22	Geothermal Well Drilling or Modification Permit	
Department of Health		
DOH 1	Notification of Hazardous Waste Activity	EPA 1
DOH 2	Hazardous Waste Treatment, Storage and Disposal (TSD) Permit	EPA 1

Table 4-1 (continued) Government Agency Permit Consultation List		
Permit	**Agency and Permits**	**Cross References of Related Permits/ Permits Delegated to Other Agencies**
DOH 3	Underground Storage Tank (UST)	
DOH 4	Underground Injection Control (UIC) Permit	EPA 3
DOH 5	Water Quality Certification (WQC) Army Corps of Engineers Section 401 Permit	
DOH 6	Authority to Construct (ATC) a Potential Air Pollution Source	
DOH 7	Permit to Operate (PTO) a Potential Air Pollution Source	
DOH 8	Prevention of Significant Deterioration (PSD)	
DOH 9	Community Noise Permit for Construction Activities	
Office of State Planning		
OSP 1	Federal Consistency With the Hawaii Coastal Zone Management Program	COE 5
Department of Transportation		
DOT 1	Permit to Perform Work on State Highways	FHA 1
Hawaii County		
HC 1	Geothermal Resource Permit (GRC)	
HC 2	Special Management Area (SMA)	
HC 3	Shoreline Setback Variance (SSV)	
HC 4	Special Permits	
HC 5	Use Permits	
HC 6	Subdivision of Land	
HC 7	Plan Approval	
HC 8	Grubbing, Grading, Excavation and Stockpiling Permits	
HC 9	Excavation of Public Highways	
HC 10	Installation of Utilities Within Federal and Secondary County Highways	
HC 11	National Flood Insurance	
HC 12	Building Permits	
HC 13	Outdoor Lighting Permit	
HC 14	Electrical and Plumbing Permits	

Table 4-1 (continued) Government Agency Permit Consultation List		
Permit	**Agency and Permits**	**Cross References of Related Permits/ Permits Delegated to Other Agencies**
HC 15	Sign Permit	
HC 16	Building Plan Approval	
Maui County		
MC 1	Department of Public Works Drainage and Erosion Control Plans	
MC 2	Board of Height Variance	
MC 3	Department of Water Supply Source and Storage Assessment	
MC 4	Geothermal Resource Permit	
MC 5	Shoreline Setback Variance	
MC 6	Special Management Area Use Permits	
City and County of Honolulu		
CCH 1	Conditional Use Permit-Type 1	
CCH 2	Special Management Area Use Permit (SMP)	
CCH 3	Shoreline Setback Variance	
Department of the Navy		
NAV 1	Notification Regarding Surface and Subsurface Plans	
Department of the Army Corps of Engineers		
COE 1	Permits Under Sections 9 and 10 of the Rivers and Harbors Act of 1899 for Structures or Works in or Affecting Navigable Waters of the United States	NMFS 2
COE 2	Permits Under Section 103 of the Marine Protection Research and Sanctuaries Act of 1972 for Ocean Dumping of Dredged Material	USF&W 1, NMFS 6, NMFS 7
COE 3	Permits Under Sections 404 of the Federal Water Pollution Control Act of 1972 and Amendments for Discharges or Dredged or Fill Material into Waters of the United States	EPA 1, USF&W 2, NMFS 1
COE 4	Water Quality Certification from the State of Hawaii Department of Health	DOH 5
COE 5	Coastal Zone Management Consistency Certification from the State of Hawaii	OSP 1
COE 6	National Environmental Policy Act (NEPA) Environmental Impact Statement	EPA 4

Table 4-1 (continued) Government Agency Permit Consultation List		
Permit	**Agency and Permits**	**Cross References of Related Permits/ Permits Delegated to Other Agencies**
National Oceanic & Atmospheric Administration		
NOAA 1	Notification to Charting and Geodetic Services	CG 1
Department of Transportation U.S. Coast Guard		
CG 1	Notification of Submerged Cable	NOAA 1
CG 2	Notification of Cable Laying Operations or Related Projects	
U.S. Fish and Wildlife		
USF&W 1	Endangered Species Act Activities Review	COE 2, NMFS 6
USF&W 2	Clean Water Act Review	EPA 1, DOH 5, COE 3, NMFS 1
USF&W 3	Rivers and Harbors Act Review	COE 1, NMFS 2
USF&W 4	Fish and Wildlife Coordination Act Review	
National Marine Fisheries Service		
NMFS 1	Clean Water Act Section 404 Permit Application Review	USF&W 2, COE 3
NMFS 2	Rivers and Harbors Act of 1899 Section 10 Permit Application Review	COE 1
NMFS 3	Clean Water Act Section 401, Water Quality Certification Application Review	COE 4, USF&W 2, EPA 1
NMFS 4	Federal Coastal Zone Management Consistency Determination Review	OSP 1, COE 5
NMFS 5	Marine Mammal Protection Act (MMPA) Exemption	
NMFS 6	The Endangered Species Act (ESA) Section 7, Consultation Process	USF&W 1, COE 2
NMFS 7	Marine Protection Research and Sanctuaries Act of 1972, Section 103 Permit Review	COE 2
Environmental Protection Agency		
EPA 1	Permits and Licenses Under Section 402 of the Federal Water Pollution Control Act of 1972 and Amendments	DOH 1, DOH 2, USF&W 2, COE 3
EPA 2	Permits and Licenses Under the Clean Air Act	DOH 6, DOH 7
EPA 3	Underground Injection Control (UIC) Permit	DOH 6

Table 4-1 (continued) Government Agency Permit Consultation List		
Permit	**Agency and Permits**	**Cross References of Related Permits/ Permits Delegated to Other Agencies**
EPA 4	National Environmental Policy Act (NEPA) Environmental Impact Statement	COE 6
Federal Highway Administration		
FHA 1	Approval for Work to be Performed on Interstate Highway	DOT 1

5. SIGNIFICANT EIS MILESTONES

Activity	Date
ANOI	September 3, 1991
NOI	February 14, 1992
Scoping Meetings	March 7, 1992 to March 16, 1992
Draft IP	August, 1992
Comments on Draft IP	September, 1992
Final IP	Fourth Quarter CY 92
Draft EIS	Third Quarter CY 93
Public Hearing and Comment Period on Draft EIS	Fourth Quarter CY 93
Final EIS	Second Quarter CY 94
Record of Decision (ROD)	Third Quarter CY 94

6. PREPARERS OF THE EIS

The Oak Ridge National Laboratory (ORNL) has been selected by DOE to assist in the preparation of the EIS on the proposed Hawaii Geothermal Project and to support all EIS procedural requirements. ORNL is assisted by the Lawrence Berkeley Laboratory in the area of alternatives and marine cable impacts. Supporting documentation and data will be provided by other federal, State and County agencies (especially those identified as cooperating agencies) and others. ORNL has the responsibility to ensure that the information meets quality assurance requirements for use in the EIS process. DOE is responsible for the scope and content of the EIS and supporting documents. NEPA disclosure statements are on file at DOE's Office of Conservation and Renewable Energy, Washington, D.C. Copies of these statements are included in Appendix B.

7. RELATED ENVIRONMENTAL DOCUMENTATION

(To be provided)

APPENDIX A

PROPOSED OUTLINE FOR THE ENVIRONMENTAL IMPACT STATEMENT

PROPOSED OUTLINE FOR THE HAWAII GEOTHERMAL PROJECT (HGP) ENVIRONMENTAL IMPACT STATEMENT (EIS)

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APPENDIX B

CONTRACTOR DISCLOSURE STATEMENTS

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF ENVIRONMENTAL IMPACT STATEMENT FOR THE HAWAII GEOTHERMAL PROJECT

CEQ Regulations at 40 CFR 1506.5 (c), which have been adopted by the DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purposes of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations", 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)". 46 FR 18026-18038 at 18031.

In accordance with these requirements, Martin Marietta Energy Systems, Inc. (COMPANY NAME) hereby certifies as follows: check either (a) or (b),

(a) [X] Martin Marietta Corp. (COMPANY NAME) has no financial or other interest in the outcome of the Hawaii Geothermal Project.

(b) [ ] _____ (COMPANY NAME) has the following financial or other interest in the outcome of the Hawaii Geothermal Project and hereby agrees to divest itself of such interest prior to initiating any technical analyses in support of this Project.

Financial or Other Interests

1.

2.

3.

Certified by:

SIGNATURE

Gary J. Draper
NAME

Manager, Contracts
TITLE

May 27, 1992
DATE

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF ENVIRONMENTAL IMPACT STATEMENT FOR THE HAWAII GEOTHERMAL PROJECT

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In accordance with these requirements, University of California, Lawrence Berkeley Lab. hereby certifies as follows: check either (a) or (b),
COMPANY NAME

(a) [X] University of California Lawrence Berkeley Lab. has no financial or other interest in the outcome of the Hawaii Geothermal Project.
COMPANY NAME

(b) [ ] _____ has the following financial or other interest in the outcome of the Hawaii Geothermal Project and hereby agrees to divest itself of such interest prior to initiating any technical analyses in support of this Project.
COMPANY NAME

Financial or Other Interests

1.

2.

3.

Certified by:

SIGNATURE

Rick Inada
NAME

Acting Head, Office of Sponsored Research
TITLE

May 27, 1992
DATE

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF ENVIRONMENTAL IMPACT STATEMENT FOR THE HAWAII GEOTHERMAL PROJECT

CEQ Regulations at 40 CFR 1506.5 (c), which have been adopted by the DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purposes of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations", 46 FR 18026-18038 at Question 17a and b.

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In accordance with these requirements, Energy, Environment + Resource Center, Univ of Tennessee (COMPANY NAME) hereby certifies as follows: check either (a) or (b),

(a) ☒ Energy, Environment + Resource Center (COMPANY NAME) has no financial or other interest in the outcome of the Hawaii Geothermal Project.

(b) ☐ _____ (COMPANY NAME) has the following financial or other interest in the outcome of the Hawaii Geothermal Project and hereby agrees to divest itself of such interest prior to initiating any technical analyses in support of this Project.

Financial or Other Interests

1.

2.

3.

Certified by:

_____
SIGNATURE

Jack Barkenbus
NAME

Acting Director
Energy, Environment + Resource Center
TITLE

May 28, 1992
DATE

APPENDIX C

A SUMMARY OF SCOPING COMMENTS

DRAFT EXECUTIVE SUMMARY
HAWAI'I GEOTHERMAL PROJECT - EIS SCOPING MEETINGS
MARCH 1992

March 7, 1992, Pahoa, Hawai'i
March 9, 1992, Wailuku, Maui
March 12, 1992, Kaunakakai, Moloka'i
March 14, 1992, Honolulu, Oahu
March 16, 1992, Waimea, Hawai'i

1. PURPOSE AND NEED

Nearly 20% of those presenting suggested that the EIS establish whether the HGP will achieve the goals of the State for the HGP: to alleviate Hawai'i's dependence on imported fuels, and to develop indigenous, cost-effective, renewable energy supply options for the State's future energy needs.

Several presenters suggested that if additional energy or energy self-sufficiency were very important, then serious attempts at conservation would have been made and laws requiring solar hot-water heating on State buildings or new homes would be passed.

In questioning the objectives of the HGP, commenters noted that planning for the development of 500 MW of geothermal power places substantial reliance on a single source of power with a high potential for failure either in power supply or cable.

Many noted that the ~~majority~~ bulk of the crude oil used in Hawai'i is used for transportation, and that electricity is generated using the residuals. Therefore, unless the need for petroleum products for transportation were reduced, geothermal power would not in any meaningful way reduce the State's dependence on imported oil. If tourism is increased due to increased power availability, tourism's reliance on oil for transportation may increase Hawai'i's dependency on oil.

2. PROPOSED ACTION

2.1 Definition of Project. About 15% of the commenters want a better definition of both phases of the HGP. The EIS should clearly delineate the federal and State's participation in the HGP. It was noted that in order for 500 MW to reach Oahu, more power must be generated at the source. The proposed action should be defined from inception through decommissioning and rehabilitation, including locations of power plants, well-heads, transmission corridors, campsites, access roads, other infrastructure and aircraft used for surveillance. The number of wells for exploration, source, and reinjection should be estimated and the acreage required to support them for the lifetime of the plant. Estimates of the number of wells that need to be drilled to result in the requisite number for source and reinjection should be based on prior experience in Puna and around the world.

As the wells for HGP are so close to sites of recent and on-going volcanic eruption, the EIS should discuss the idea that the superstructures associated with the wells will be portable.

2.2 Resource Concerns. Some commenters were concerned that the magnitude of the resource in the Kilauea East Rift Zone has not been verified. The EIS should discuss the reliability and renewability of the resource (~15% of the commenters). The EIS should investigate the effect of the need for expansion into additional land as the resource declines.

2.3 Geothermal Project Reliability. The EIS should discuss the reliability of the geothermal power generation facility (>25% of those presenting), and associated infrastructure, some noting mistakes that had been made in the past. Those concerned about the reliability of the geothermal facilities mentioned the potential hazards of locating such plants (and transmission lines) in an active seismic/volcanic zone, of isolation from the base load (both at the facility and to the users), of irreparable wells, and of uncontrolled and unabated blowouts. They were concerned about the integrity of well-casings and the possibility that brine ponds might overflow during heavy rains or leak due to the corrosive nature, high temperature, and high pressure of the geothermal fluids. Others were concerned about availability of water for quenching.

Thus, the EIS should identify and assess potential impacts of failure modes. It should examine the unique geological system with which the HGP will interact, examining ~~examine~~ the potential for seismic/volcanic events interconnecting aquifers resulting in contamination.

The EIS should identify and assess the impacts associated with the need for stand-by backup power for those using the geothermal power in order to maintain system reliability.

2.3.1 *Mitigation Methods*. Proposed and alternative abatement and mitigation measures should be described and their potential impacts identified and assessed, including: best available control technologies, measures to prevent invasion of exotic species, reforestation techniques (*i.e.* reforest, restock with biota *etc*.), and disposal of hazardous waste. Backup measures should be included. The EIS should state how monitoring, mitigation, and enforcement measures advocated by the document will be guaranteed.

2.4 Cumulative Impacts. The commenters were concerned about whether the impacts of prior and on-going geothermal development would be considered in the EIS. They do not generally hold either the past or present geothermal development or developers in high regard (suggesting that the many failures are due to improper operation). Others noted that geothermal energy has been successful elsewhere. Twenty percent of those

presenting mentioned the effects that have already occurred in the Puna district: health effects, both physical and psychological (due to geothermal emissions and noise), and impacts to agriculture, livestock, and other plants, animals and birds both in and out of the Wao Kele o Puna rainforest. Some residents were forced to leave their homes during recent venting incidents. The presenters also ~~noted~~ claimed increased depreciation of material and lowered property values and that community and individual rights were violated.

The EIS should assure that incidents, such as those that occurred at PGV (Puna Geothermal Ventures) in 1991, do not occur with the HGP noting that PGV is a small scale operation relative to HGP. This includes reviewing previous incidents and implementing the recommendations of the expert review team. The commenters expressed concern that, to date, geothermal developers have not provided citizens with accurate information concerning their operations and releases.

The presenters also noted that environmental examination of geothermal development to date has been segmented, inadequate, and performed using a very limited data base and perspective. Some prior environmental compliance documents did not address the reasonably foreseeable consequences of a successful projects, were inadequate, and conditions for operation and mitigation were not followed.

2.5 Cable/Transmission Lines. The EIS should describe the submarine cable, the transmission lines, pumping stations and other infrastructure, their reliability, and efficiency (~20% of those presenting). It should identify the primary and alternative route. Those presenting suggested that the EIS should address impacts associated with cable/transmission line installation, operation, maintenance, and failure. They asked if the submarine cable was technically/economically feasible and reliable (in terms of placement, operation and maintenance), considering the depths, bottom roughness, frequency of debris flows, and extreme oceanic conditions in the Alenuihaha Channel. Similarly, they asked about: the reliability of the system if it were subjected to a seismic or volcanic event; the implications of possible sabotage of the cable; whether shark bites or ship anchors will damage the cable; and if the grid on Hawai'i can safely distribute the power associated with HGP. They expressed concern that parallel transmission lines along the Kea'au road makes the system vulnerable [to seismic events, volcanic events, extreme events (storms), sabotage]. They noted that if lines are broken, any escape route from Puna could also be cut off.

The EIS should outline repair strategies and state how long repairs will take.

2.6 Future Uses. About 15% of the presenters suggested that the EIS identify and assess the potential impacts of the future uses of geothermal energy on all islands affected: increased greater urbanization, growth, industrialization, and development that could include: seabed mining and refining, construction of a space port,

and increased tourism with associated golf courses and energy-intensive hotels. It should examine negative impacts on the infrastructure, overpopulation, crime, or social upheaval.

The commenters suggested that increased power availability could cause increased population and power consumption. They noted that increased tourism could result in increased use of fuels for transportation, thereby increasing Hawai'i's dependence on oil.

It was noted that once the submarine cable was in place, that other power generation facilities could use the cable as a conduit, in fact, laying of the cable could make construction of other energy-production facilities economically feasible.

3. ALTERNATIVES TO THE PROPOSED ACTION

Nearly fifty percent of the commenters stated that the EIS should identify and assess the relative merits and impacts of alternative energy supply options that are cost-effective, viable and safe, and could ~~to~~ meet the goals of the State's stated purpose for the HGP. The EIS should examine their technical and economic feasibility/reliability, and their environmental impacts. These include "no action," fossil fuel options (coal gasification), conservation and renewables, and various geothermal options. They should be considered within the framework of integrated resource planning and least-cost planning of supply- and demand-side energy options as this may provide a lower-cost energy supply than geothermal in terms of both economic and environmental cost. They noted that the State is initiating such a process (but may not be completed within the proposed time ~~scale~~ of the EIS).

3.1 Conservation and Renewables. Nearly 40% percent of the commenters stated that the EIS should examine conservation and renewable energy-supply options, such as photovoltaics, solar thermal (particularly solar hot water heating), wind, OTEC, biomass, demand-side options (conservation/energy efficiency, passive solar), off-grid options, and others. Many believe that alternative energy options can meet the needs of the State, if the alternative energy supply options could be helped by tax-incentives and low-cost loans. They noted that wind, solar and biomass are successful elsewhere and that the most islands have excellent wind and solar resources.

3.2 Geothermal Alternatives. With respect to geothermal alternatives, commenters want the EIS to assess a staged development of HGP so that experience is gained with the least capital costs, the possibility of closed-cycle geothermal using immediate reinjection, *in-situ* heat exchange, and geothermal development at locations other than the Kilauea East Rift Zone.

If a low level of geothermal development is successful, then greater development of up to, or even greater than 500 MW, become reasonable-foreseeable future developments. One commenter noted that if geothermal development is successful at the 25 MW level, then it would not be economical or politically astute to limit development to that low level of development on the Big Island or (if sufficient resource is verified) to the Big Island. Therefore, it is important that the EIS look at the impacts of developing the full resource and all its potential uses.

3.3 Alternatives to the Cable/Transmission Lines. Alternatives to transmission lines should be considered including "no action," solid rather than oil-filled cables, high voltage AC transmission *vs* high voltage DC transmission, and various cable/transmission line routes (above ground *vs* buried, percentage of lines on land *vs* submarine). A number of alternative routes were suggested including an alternative to the route along the southeastern coast of Maui: North Kohala to Lana'i with spur lines to Lahaina and Moloka'i and direct line from Lanai to Oahu; or routing the cable directly to Oahu, not landing on Maui. The EIS should consider the costs (including indirect costs, such as impacts to property values and aesthetic impacts) of above and undergrounding the transmission lines. This could be necessary on a district by district basis, given the variable geology of the State. Prior to development of the HGP plus cable a smaller demonstration should be conducted to determine whether power transmission to other islands is reasonable.

3.4 Transportation. The EIS should examine reducing Hawai'i's dependence on petroleum-based fuels for transportation (for example, using fuel-efficient automobiles) in order to reduce Hawai'i's dependence on imported oil. The EIS should examine the potential contributions of alternative transportation fuels, providing on-site or near-site employee housing, alternative methods for interisland travel. However, the EIS should examine the costs associated with supplying an unneeded mass transit system on Oahu to save energy.

3.5 Fossil Fuel. The EIS should identify and assess the impacts of fossil-fuel-fired operations, particularly the obtaining of foreign coal, and the environmental effects of these operations. The EIS should address the issue that fossil-fuel power generation adversely impacts air quality and potentially contributes to global climate change. The proposed coal-burning facilities may use coal derived from strip mining a rainforest in a third-world nation. The commenter implied that there are international implications of asking third world nations to cease cutting their rainforests and then economically encouraging them to clear those rainforests.

4. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A number of studies of the affected environment were suggested, including: characterization of the affected environment (including socioeconomics), ground water, the hydrology and geology of the Kilauea East Rift Zone,

local meteorology, natural (ambient) emissions, and geothermal emissions, fluids, and solid wastes. Surveys of the biota in the Kilauea East Rift Zone region, and all the proposed overland and undersea transmission corridors should be carried out and the archeological sites on the southeastern coast of Maui should be analyzed.

5. POTENTIAL ENVIRONMENTAL ISSUES

The EIS should fully evaluate the short- and long-term environmental, social, and economic costs and benefits of the HGP (including wells, support structures, transmission lines/submarine cable, pumping stations, campsites, access roads, and aircraft used for maintenance reconnaissance), particularly to pristine environments, such as the Wao Kele o Puna rainforest, the southeast coast and Hana districts of Maui, much of Moloka'i, and the marine environment. The EIS should not only consider local impacts, but should take a planetary or global perspective. The preparers of the EIS should consider the fact that the Hawaiian islands are finite, and consider, therefore, if the HGP is consistent with this limitation on growth.

Commenters expressed a general requirement to protect the land and its biota as a responsibility of those living on it. Commenters noted that when assessing the impacts of the HGP, there should be no artificial separation of humans from the environment.

DOE should perform the environmental studies necessary to provide the scientific data required to weigh the costs and benefits of the HGP and should make the information available to the public. However, the commenter noted that studies that would be intrusive should not be performed. The EIS should clearly state information gaps and their significance. When measurements (for monitoring or other purposes) are taken. they should be performed by analysts with appropriate expertise and at appropriate locations.

A number of issues were raised that apply to many of the categories below. The EIS should identify and assess (1) the chronic effects of HGP-related high- and low-level emissions, effluents, noise, and night light on plants, animals, birds, and insects, in the wild, in the rainforest, on agricultural lands and on humans (see Health and Safety); (2) the impacts on plants and animals of medicinal and ritual use for Native Hawaiians (The EIS should also address the impacts of the loss of benefits of these plants.); and (3) the impacts of the HGP on plants, animals, birds, and fish used for subsistence living. The EIS should present measures that would be used to assure that herbicides used to prevent invasion of exotic species will affect only target species either within or outside of the target region. It should demonstrate that these mitigation measures will be carried out and how they will be enforced. Herbicides so used can impact terrestrial and aquatic biota within or outside the rainforest, including threatened and endangered species. They can enter the human food chain in drinking water, air of food.

Many of those presenting questioned the impacts of acid rain or fog that may occur as a result of geothermal development, which can impact air, water and soil quality, terrestrial and land-based aquatic ecosytems, and have significant socioeconomic effects. Concern that emissions would cause acid rain resulting in excessive corrosion of piping or building materials or that emissions would discolor or erode paint *etc.*

The EIS should establish whether the clearing of land for HGP would exacerbate erosion affecting air and soil quality and terrestrial and aquatic land-based ecosystems. Increased erosion could cause increased siltation and turbidity potentially impacting the near-shore environment including fishponds and fisheries, reefs, and tourism (economic, cultural and archeological concerns).

5.1 Competing Uses. Nearly 30% of those commenting recommended that the EIS consider the propriety of: (1) geothermal development in the residential neighborhoods of Puna, noting that blowouts occur at most geothermal installations world-wide; (2) using Native Hawaiian homelands, ceded lands and conservation districts for the HGP, even though some of those lands are not currently being developed because they have no supporting infrastructure; and (3) the land exchange in Puna [Campbell Estate for Wao Kele o Puna], and subsequent redesignation as a geothermal subzone, to determine whether it has benefitted Native Hawaiians. The commenter noted that there are already long waiting lists for resettlement of those lands and using some for the HGP may exacerbate the situation.

In addition the EIS should address the impacts of the HGP on water availability and water uses. The EIS should determine if there is sufficient water with in the Kilauea system to support the HGP and provide for other uses. In addition, fire hazards associated with the transmission line system exacerbated by drought conditions were mentioned. The EIS should address the impacts of the absence of registration of geothermal wells as water wells, as some Native Hawaiians have claimed water use rights for the subsurface waters in the Puna district.

The EIS should consider impacts of the HGP on aviation, communication, agriculture, and on recreational uses, for example in the rainforest and on beaches.

The EIS should examine how the possibility of geothermal development has influenced land ownership and land-use decisions.

5.2 Air Quality Concerns. More than 20% of the presenters recommended that the EIS characterize the emissions associated with the 500 MW development and identify the impacts of those emissions, including toxic releases, acid rain or fog, and thermal pollution, and particles from solid wastes. Certain atmospheric conditions

were reported to exacerbate the effects of HGP-related emissions in Puna, and even degrade the air quality on Maui and Moloka'i. Geothermal emissions can affect the water quality in catchment systems, commonly used in Puna for drinking and bathing.

5.3 Water Quality Issues. Nearly 25% recommended that the EIS characterize the effluents and the brine ponds associated with the 500 MW development. The EIS should report the impacts of leakage of source and injection wells into aquifers due to well failure (due to seismic/volcanic events or corrosion), or leakage/overflow from the brine ponds. The EIS should address impacts of the HGP on drinking water quality (particularly in water catchments), on surface or ground waters, considering the effects of possible contact with HGP-related solid wastes, abatement technologies or their possible failures, and changing the water quality designation of aquifers in the geothermal subzone.

5.4 Ecological Resources. Nearly 50% of the presenters asked that the EIS examine the project's impact on the unique ecosystems that make up Hawaii including plants, vertebrates, and invertebrates. Many of the concerns raised could be applied to more than one ecosystem: terrestrial, land-based aquatic, or marine ecosystems and the threatened, endangered and endemic species therein and on humans. Many have been discussed in the introduction to section 5.

5.4.1 *Impacts to Terrestrial and Land-based Aquatic Ecosystems*. In addition to the concerns mentioned in the introduction to Section 5, 25% of the commenters recommended that the EIS should address the potential impacts of the HGP on unique species, for example insects, that live in lava tubes.

5.4.2 *Rain Forest Issues.* Nearly 30% of those commenting expressed concern for the rainforest. The EIS should identify and assess the impacts of the HGP (particularly in terms of species diversity and its ability to regenerate), including the effects of introduction of exotic species, extensive segmentation caused by roads built and areas cleared, and incursions of humans. The EIS should also study the impacts of destroying the unique and fragile habitat of the Wao Kele o Puna rainforest. It should note the interrelationship between the lava, the biota of the region, and the regeneration that occurs following an eruption.

One commenter was concerned that the construction of the HGP would start a series of complex changes in the lowland rainforest ecosystem. He stated that the "long-term longitudinal study" necessary to understand this effect would be difficult to conduct for the EIS, making it equally difficult, if not impossible, to predict the consequences of those changes. Thus, the EIS should assess the risks of making a complex environmental decision without information regarding the impacts.

5.4.3 *Threatened, endangered, or endemic species concerns*. Nearly 20% of the presenters were concerned about the potential impacts of the HGP on threatened, endangered, and endemic species, particularly in the rainforest of Puna, the dry forest on Maui, and in the ocean. Species mentioned include humpback whales (particularly nursing mothers and their offspring), sea turtles, ohia, happy-face spider, Hawaiian hawk, and hapu'u (tree fern). The EIS should consider that, because of the unusual geology in Hawai'i (criss-crossing lava flows, all islands), very small areas of unique habitat exist that support the few remaining individuals of an endangered species that are evolving at different rates.

One speaker stated that he believed that if there were "take," even inadvertent, in a federally-funded project then the project would be stopped. Another commenter asked what happens if species become extinct as a result of HGP.

5.4.4 *Marine Concerns*. Nearly 20% of the commenters requested that the EIS should investigate the impacts of the submarine cable installation and maintenance (increased turbidity, possible ciguatera, and increased noise levels), normal operation (emf, stray voltage, electrotaxis), and in failure modes (such as oil leakage) on the ocean and its resources including: marine mammals, sea turtles, big game fish, dolphins, food stocks, sharks, rays, and skates; and on beaches, surfing locations, and reefs; and on ecology in the coastal zone.
The EIS should investigate the impacts of the cable on humpback whale migration patterns, birth rate, and ability to navigate and locate and the potential impacts of nets (used to protect swimmers if the submarine cable attracts sharks) on humpback whales' birthing habits in shallow, protected waters.

The EIS should investigate the impacts the HGP would have on fisheries. The EIS should consider the impacts of the cable (installation, operation, maintenance *etc.*) on the reefs and fish ponds.

5.5 Geological Issues. The commenters expressed concern that undertaking geothermal development in a seismically and volcanically active zone may, in fact, exacerbate those activities and upset the hydrological balance as the development will be situated on a geological structure that contains numerous vertical dikes, faults, and horizontal shelves. The EIS should examine the problem of geothermal associated subsidence.

5.6 Aesthetic Issues. The EIS should address the aesthetic impacts of HGP-related noise, visual disturbances and odors. Although noise is primarily a Health and Safety Issue, it is also an aesthetics issue as it is a nuisance, disrupting peace and quiet. Commenters want the EIS to address the impacts of chronic exposure to nuisance levels of noise associated with geothermal development, including drilling, operation and venting, and transmission lines.

Commenters expressed concern about the aesthetic costs of the HGP, (particularly the impacts of the overland transmission lines and clearing the Wao Kele o Puna rainforest) on all islands, including impacts to natural and agricultural landscapes, beaches and surfing spots. One commenter mentioned the problems of night-time lighting.

5.7 Health and Safety Issues. The EIS should assess the health and safety impacts of the HGP and its components, failures, mitigation measures, and future uses (more than 40% of those presenting).

5.7.1 *Geothermal Emissions and Effluents*. About 25% of the commenters expressed concerns about the health effects of geothermal emissions (particularly H_2S and acid rain) and effluents, due to HGP-related changes in air, drinking water, and food quality. These effects can include eye, throat irritation, and noise irritation, trouble breathing, coughing, wheezing, and lowered resistance to infection. Those presenting were concerned about the cumulative and synergistic effects of emissions, effluents, and brine ponds, on children and babies, those with respiratory ailments, the elderly, Native Hawaiians, and workers. The EIS should analyze the short- and long-term chronic and acute effects of geothermal emissions on public health and safety.

5.7.2 *Transmission Line Effects*. The EIS should examine the health and safety impacts of the transmission line/underwater cable system (including transformers), particularly the effects of electromagnetic fields and stray voltage along the transmission line corridor, or ciguatera associated with cable construction in the near-shore environment.

5.7.3 *Noise*. The EIS should address the impacts of noise associated with geothermal development, including drilling, operations at and near the geothermal facility under normal operating conditions and with unscheduled venting, and also along transmission lines, at work camps or substations, and due to aircraft (doing maintenance reconnaissance). They note that noise can cause ear damage; and it can cause fear, loss of sleep, and psychological stress.

5.7.4 *Psychological Impacts*. The commenters recommend that the EIS address psychological impacts of the HGP and its associated development, including impacts of stress due to fear, unannounced venting, and sleep deprivation (due to noise, fear, frustration, and lack of trust) and the problem of the fears of geothermal development that exist in the surrounding communities due to the prior activities in the region. They asked what the psychological impacts are on a community experiencing controversy, lack of empowerment, and loss of due process. The EIS should consider psychological impacts on persons whose lifestyle had been disrupted (for example, children and Native Hawaiians) and cross-cultural psychological issues.

5.7.5 *Safety, Civil Defense Issues*. With respect to geothermal developments in residential areas, the commenters strongly urged that the EIS should develop a worst-case scenario for the full development and, noting that there is no adequate emergency response plan for the Puna District, develop one. Residents are concerned about impacts of isolation of the facility from the base load, which could result in unabated and/or uncontrolled venting. The transmission lines parallel the Kea'au road, which is also the evacuation route from Pahoa. If a seismic or volcanic event should occur along that road, the facility could be isolated from its base load and the community would be prevented from evacuating. They also mentioned inadequate communication systems.

The EIS should address the impacts of the violence that might occur should the HGP proceed.

With respect to the submarine cable, the EIS should: state what steps will be taken to protect the public and the cable if it attracts sharks; consider the implications of possible sabotage of the cable; and address the risks of accident during maritime operations in the Alenuihaha Channel. The EIS should consider the civil defense issue of a major segment of power generation capacity being linked by such a transmission connection to its load.

The EIS should identify and assess the hazards of overland transmission lines, including the potential of increased fire danger and electrical hazards associated with high tension lines. The EIS should remember that the HGP may cause increased population, which would (along with drought conditions which do occur on the Big Island) further exacerbate the problems mentioned above.

5.8 Political Issues. Fifty percent of the commenters expressed political concerns of one kind or another, noting their frustration. These comments were in regard to a lack of concern by government, loss of due process because of government regulations and actions, loss of faith in government, lack of necessary expertise within government, and skepticism regarding motives and resolve of government. The commenters mentioned infringement on privacy due to the actions of geothermal developers' security personnel, insufficient public review, and inadequate distribution of information.

Commenters also questioned why the State does not wait until the IRP process is over to develop geothermal and why some solar installations are not already required.

The commenters believe that State/federal governments should enforce the laws currently in existence (including permitting and monitoring requirements). They noted that the State has never set air quality standards for H_2S. They asked if regulations have been violated in the past, are they currently being violated and will they be in the future?

The EIS should consider the international implications of the messages conveyed by the U.S. to the international community, noting that U.S. actions, far more than words, help establish global policy. Thus, the EIS should address concerns about the example it sets for the global community when the U.S. permits cutting of the rainforest for the purpose of power generation (when it asks that other nations not cut theirs) and does not show respect for the cultural and ethnic resources of its citizens, *i.e.* Native Hawaiians.

5.9 Socioeconomic Issues. Almost 75% of those commenting expressed concern about the long- and short-term socioeconomic impacts of the HGP detailed below.

5.9.1 *Economic Issues*. Nearly 40% of the commenters expressed economic concerns. They asked that the EIS lineate the costs (past, present, and future) of the entire HGP project to consumers, users and non-users, taxpayers, and utilities, from inception through decommissioning and rehabilitation, including all State and federal developmental and court costs, and costs for publicity *etc*, drilling and wells, building new ships, harbours, and the cable *etc*., mitigation, and rehabilitation, and monitoring and enforcement. It should examine the economic feasibility and cost-effectiveness of the project. It should consider the cost of cable or facility failure once geothermal energy provides a significant proportion of Hawai'i's energy needs, including the costs associated with a declining resource, of repair, and of development of backup capacity. The EIS should identify who would be responsible for the consequences of lower property values or property condemnation associated with the HGP.

The EIS should (1) address the economic impacts should the submarine cable affect fisheries (including fishponds), big game fish and food stocks, or tourism; (2) evaluate the impacts of the HGP (and the effects of its presence making large regions of the State less desirable for living) in terms of lower property values (including condemnation), increased cost of living, *etc*., loss of crops or livestock, increased depreciation (*e.g.*, of fences, houses, and catchment systems) due to geothermal-related corrosion; (3) examine the economic impacts of geological risks and hazards, the impact of the indebtedness incurred; (4) consider impacts to businesses (including agriculture), such as job loss, business relocation, or loss of business; and (5) assess impacts to local economies.

The EIS should identify who is liable - the federal government, the State, and/or privately-owned corporations - for all costs incurred and should mandate that conditions of permits should include future liability clauses. The EIS should identify means to provide insurance for those whose property values (*etc.*) decline or are forced to move due to the HGP.

The EIS should consider the impacts of diverting funds that could be spent on conservation technologies to the

geothermal effort. One commenter noted that investment in conservation has resulted in changing patterns of investment toward technologies that reduce the need for energy consumption. Investment in conservation technologies save the costs of constructing/updating additional generation/transmission facilities.

5.9.2 *Life Style*. The EIS should address impacts of the HGP on the life styles of the general population, specifically on Native Hawaiians. They ask if the cable/transmission lines will affect, for instance, subsistence life styles, the ability to access beaches, and the lifestyles of those who prefer privacy, peace and quiet, or lower levels of population, technology, or development (*e.g.* off-grid living).

5.9.3 *Social Issues*. The EIS should address the social effects the HGP, or its failure, particularly on communities near the geothermal operations and along proposed cable routes, including the social consequences of increased cost of living due to HGP. It should identify and assess the socioeconomic costs due to a decline in resource after HGP has stimulated growth and evaluate the social costs of HGP-related civil disobedience. One commenter noted that Hawai'i, which has largely service-related jobs has a low unemployment rate, whereas industrialized regions of the country are where the high unemployment occurs.

5.9.4 *Native Hawaiian Issues*. Nearly 50% the commenters were concerned that the EIS respect Native Hawaiian race, rights, religion, history, language, and culture. Many expressed the belief that geothermal development would result in a desecration of Pele.

The commenters asked that the EIS examine potential impacts of the HGP on: Native Hawaiian culture and religious beliefs; the ability of Native Hawaiian practitioners to obtain herbs, animals, and birds necessary for medicinal and ritual practices; Hawaiian homelands or ceded lands (noting that Native Hawaiians have a right and spiritual need to be able to return to their homelands and live their chosen life style); Native Hawaiian subsistence hunting, fishing, and gathering; and the land, ocean, and natural phenomena considered sacred. They expressed concern that HGP construction will result in desecration of ancient or modern Hawaiian burials in lava tubes, heiaus and places sacred to Native Hawaiians. The EIS should consider that for Native Hawaiians, the cultural impacts of the HGP could result in psychological stress, feeling of loss of self, and breakdown of the ohana (extended family).

The EIS should address the anthropological impacts of the HGP. A commenter recommended that the study be designed by trained anthropologists, and should involve personal interviews with practitioners, Hawaiian kupunas, and Hula dancers, in order to investigate the impact the HGP would have on cultural practices.

5.9.5 Impacts to Cultural Resources (Archeological/Historical Sites and Regions. Other speakers indicated that the EIS should assess potential impacts to the many important, and often undocumented, archeological and historical sites and regions, including the southeast coast of Maui, the south coast of Moloka'i, and North Kohala.

6. COST BENEFIT ANALYSIS

Nearly 30 % of the commenters declared that the EIS should state what the economic benefits of the HGP are, identify who receives them, and weigh the potential benefits of the HGP against the environmental costs. The commenters wanted to assure that consumers and tax payers receive some of the benefits. The presenters would like the EIS to address the concern that those who will bear the greatest cost in terms of health and safety, economics, cultural resources, and environmental losses, will not be the ones to benefit.

7. LEGAL ISSUES

The EIS should review of all applicable rules, regulations and statutes, including NEPA, the National Historical Preservation Act, the Native American Religious Freedom Act, the Endangered Species Act, Section 7 consultation and the Public Utilities Regulatory Policy Act of 1978.

The EIS should address the need for geothermal wells to be registered as water wells based on the definition of a water well in the State Water Code. The EIS should examine the complex regulatory situation with respect to land use and geothermal subzone designation.

APPENDIX D

ACRONYMS AND ABBREVIATIONS

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AC	alternating current
ALARA	as low as reasonably achievable
ANOI	Advance Notice of Intent
BACT	best available control technology
CEQ	President's Council on Environmental Quality
COE	Department of the Army Corps of Engineers
CO_2	carbon dioxide
CFR	*Code of Federal Regulations*
DBED	State of Hawaii Department of Business and Economic Development and Tourism
DC	direct current
DLNR	State of Hawaii Department of Land and Natural Resources
DOE	U.S. Department of Energy
DOH	Department of Health
DSM	demand-side management
EIS	Environmental Impact Statement
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
FEMA	Federal Emergency Management Agency
FR	Federal Register
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information System
GRSs	geothermal resource subzones
H_2S	hydrogen sulfide
HGP	Hawaii Geothermal Project
IP	Implementation Plan
IRP	integrated resource planning
kV	kilovolt
LBL	Lawrence Berkeley Laboratory
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NSF	National Science Foundation
OR	U.S. Department of Energy - Oak Ridge Operations Office
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
OTEC	ocean thermal energy conversion
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SCS	U.S. Soil Conservation Service
SHPO	State Historic Preservation Office